Original Article

Subtrochanteric valgus osteotomy in developmental coxa vara

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Abstract

Background: Valgus subtrochanteric osteotomy is the gold standard surgical treatment of developmental coxa vara. Nevertheless, there has been no consensus on the method of fixation and osteotomy details. In the literature, there are few reports on employing rigid internal fixation methods that preclude the need of postoperative immobilization. We present early radiologic and clinical outcome of a modified Y shaped subtrochanteric valgus osteotomy fixed with precontoured DCP.

Patients and Methods: Ten patients with 10 hips of developmental coxa vara were subjected to a corrective Y-shaped subtrochanteric valgus femoral osteotomy. All the cases were fixed by a precontoured small dynamic compression plate (DCP). There were six males and four females. The right hip was affected in four patients and the left hip in six. The average age at the presentation time was 5.1 years (range 4–9 years). Clinical evaluation was done by IOWA hip score.

Results: Clinically, the IOWA hip score improved postoperatively significantly (P<.05). The average preoperative head shaft angle was 94° (range 85°-100°) and the average post-operative head shaft angle was 120° (range 115°-125°). Postoperatively, the average epiphyseal-Hilgenreiner angle and the head-shaft angle fell into the normal values. No recurrence of deformity was reported.

Conclusion: The Y-shaped subtrochanteric valgus osteotomy with rigid internal fixation precludes the use of external immobilization attained satisfactory clinical and radiologic results with no evidence of deformity recurrence on the short-term follow-up.

Key words: Developmental coxa vara, valgus subtrochanteric osteotomy, contoured dynamic compression plate

Introduction

Herring classified coxa vara into developmental coxa vara (DCV), acquired coxa vara and coxa vara associated with congenital femoral deficiency.[1] While acquired coxa vara may be due to a variety of causes such as trauma, slipped capital femoral epiphysis, Perthes disease, infection, rickets and skeletal dysplasia, the term "developmental coxa vara" is reserved for coxa vara in early childhood with characteristic radiologic changes with or without other skeletal abnormalities.[2] The goal of surgical treatment is to stimulate the ossification and healing of the defective femoral neck and subsequent normalization of the neck shaft angle.[1,2] Indications of surgical intervention are based upon the degree of symptomatology and the value of epiphyseal-Hilgenreiner angle (EHA).[1-4]

Valgus proximal femoral osteotomy has been practiced by many authors and is the gold standard surgical treatment of developmental coxa vara.[4-9] Fixation of the osteotomy has been achieved by various methods including external fixation, internal fixation with pins and cerclage and a variety of plates.[1,2,4-7] To the best of the author's knowledge, the literature reporting the use of rigid internal fixation that precludes the use of external hip spica immobilization is scanty.[4] A 140°-angled blade plate was utilized to fix a valgus trochanteric osteotomy, but the authors used a postoperative hip spica until osteotomy healing.[6] Pauwel described a Y-shaped intertrochanteric osteotomy and used tension band wiring for fixation of osteotomy which again needed a spica fixation until osteotomy healing.[7] Cordes *et al*. performed Pauwel's intertrochanteric Y-shaped osteotomy on patients with coxa vara of various etiologies and used tension band wiring for fixation which again necessitated a hip spica postoperatively.[9] Similarly, an alternative method of internal fixation by a dynamic compression hip screw was also employed.[1,2] The purpose

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of the study is to present the early radiologic and clinical outcome of a Y-shaped, subtrochanteric valgus osteotomy with rigid internal fixation by precontoured DCP without external immobilization. Additionally, the author presents a modification of the Pauwel's Y-shaped intertrochanteric osteotomy.

Materials and Methods

The study was conducted between September 2006 and March 2008. The study has been approved by the ethical committee of our university hospital. Ten patients (10 hips) of developmental coxa vara (DCV) were subjected to a corrective valgus subtrochanteric femoral osteotomy. There were six males and four females. The right hip was affected in four patients and the left hip in six. Limping was the main presenting symptom in all patients. The average age at the presentation time was 5.1 years (range 4–9 years). The average follow-up was 29 months (range 16–39 months).

The patients with coxa vara secondary to other etiologies such as slipped capital femoral epiphysis, Perthes disease, trauma, infection and metabolic and skeletal dysplasias were excluded. Patients with avascular necrosis of the capital femoral epiphysis and hip subluxation and with recurrence after a previous femoral osteotomy were also excluded. Radiologic inclusion criteria were an EHA of more than 45° and a head-shaft angle (HSA) of less than 110°, with or without the triangular ossific fragment at the infero-medial part of the neck.

Clinical assessment of patients was performed according to the IOWA hip score.[10] The total IOWA hip score is 100 points, where 40 points are allocated for pain, 30 points for function, 15 points for gait and 15 points for anatomical assessment. All the patients were subjected to plain AP radiographs for the pelvis and both hips in neutral rotation and frog leg lateral views. Only one patient underwent a skeletal survey due to suspicion of bony dysplasia, however an endocrinologic workup was unremarkable. The EHA was measured in AP radiographs. It represents the angle between the Hilgenreiner line and a line drawn parallel to the physis of the proximal femur. The HSA was also measured. It represents the angle between a line perpendicular to the upper femoral epiphysis and the femoral shaft axis.

Operative procedure

A straight lateral approach to the proximal femur was used. The angle of correction was determined by tracing paper on plain AP radiographs of the pelvis with both hips, taken in neutral rotation. A line parallel to the Hilgenreiner line was drawn a few centimeters below the lesser trochanter. Lines parallel to femoral shaft axis and the physeal plate were also drawn. The angle measured between the Hilgenreiner and the physeal plate lines minus 16° (degree) denoted the amount of deformity and, consequently, the correction required. Preoperative contouring of a small DCP with 6–7 holes was done to the desired angle of correction. Bending of the plate was done maximally after the second hole. The precontoured plate was placed on the lateral aspect of the deformed proximal femur and checked under image intensifier so that the femoral neck fragment would later accommodate the first two screws. Then, the most proximal screw was taken through the femoral neck to stop short of the physeal plate and checked by image in two planes. A cautary marking on the femur was done just below the second hole which marked the level of the proximal transverse limb of the osteotomy. Then, the plate was rotated proximally over the first screw to give room for performing the osteotomy. Before executing the osteotomy, two K wires were inserted just proximal and parallel and distal and parallel to the transverse and oblique limbs of osteotomy, respectively. The proximal transverse limb of the osteotomy was carried out taking care not to violate the medial cortex. Then, at a more distal point on the lateral cortex which determines the base of the wedge corresponding to the angle of deformity measured, the distal oblique limb was taken so as to intersect with the transverse limb at a point two-thirds the way between the two cortices. The triangular wedge was removed and the osteotomy was closed. The two intersecting K wires should then be parallel indicating optimal correction of deformity. K wires were then removed. The most proximal screw was tightened and the second screw in the femoral neck was taken. The distal fragment was secured to the plate by at least three screws [Figure 1]. No postoperative immobilization was necessary. Weight bearing was delayed to 8 weeks.

Radiologic evaluation of healing was done at 3 months and then monthly if required. Radiologic measurements relevant to deformity correction were assessed on immediate postoperative radiographs taken at 6 monthly intervals. The clinical scoring system was also applied at 6 monthly intervals.

Results

The preoperative and postoperative clinical and radiologic results are given in Table 1. Improvement in the mean IOWA hip score from pre to postoperative values was statistically significant ($P<.05$). The average preoperative HSA was 94° (range 85°–100°). Postoperatively, the average HSA was 120° (range 115°–125°). The maximum amount of shortening in the affected limb was 1.5 cm except for one hip that had 4.5 cm shortening. Osteotomies completely united at an average time of 3.8 months (range 3–5 months). In all but one case, shortening of the affected limb was below 2 cm. The only exception was a 9-year-old female patient who had unilateral affection and 4.5 cm of shortening. The final follow-up of this patient revealed improvement of shortening to 3 cm [Figure 2]. No cases of recurrence of deformity or premature proximal femoral physeal closure were reported at the final follow-up visit. No cases of avascular necrosis or hip subluxation were encountered. Three patients developed keloid formation of the surgical scar.

Discussion

Developmental coxa vara is a hip deformity characterized by a defect in endochondral ossification of the medial portion of the femoral neck, together with progressive vertical inclination of proximal femoral physeal plate and shortening and decrease of neck shaft angle.[1,2] There is general agreement in the literature that valgus osteotomy at a trochanteric or subtrochanteric level is the most definitive method for achieving the surgical correction, which are correction of neck shaft angle and horizontal reorientation of the growth plate.[1,2,4-11] Nevertheless, there is no consensus in the literature about the osteotomy details and fixation method. Proximal femoral osteotomy has been employed without internal fixation with the obvious need of a hip spica postoperatively.[1,12] The author of the present study believes that methods of internal fixation reported are not rigid and stable enough to preclude the use of a postoperative spica especially tension band wiring.[6,7,9] The author believes that an important advantage of the contoured small DCP employed in the present study is that the two screws of the proximal fragment have bicortical purchase. This is in contrast to the angled blade plates and pediatric hip screws where the blade or screw ends in the medulla distal to the physis lacking any rigid cortical purchase. Similarly, valgus osteotomy utilizing an external fixator is inconvenient for patients postoperatively and should be reserved for coxa vara due to other etiologies where other complex multiplanar deformities need to be addressed.[11,13] In the present study, a rigid internal fixation of the osteotomy was performed by means of a small DCP to obviate the need of any postoperative spica immobilization. This conforms

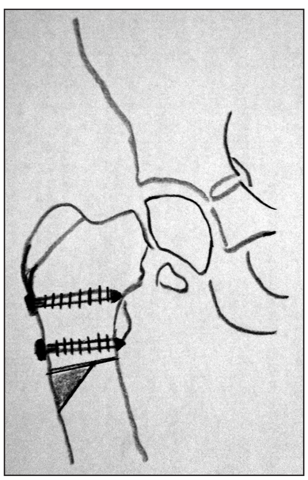

Figure 1: Geometric plan of Y-shaped osteotomy. Note the shaded triangular area is the lateral wedge to be removed and closed, while the continuation of the osteotomy line is the medial wedge to be opened

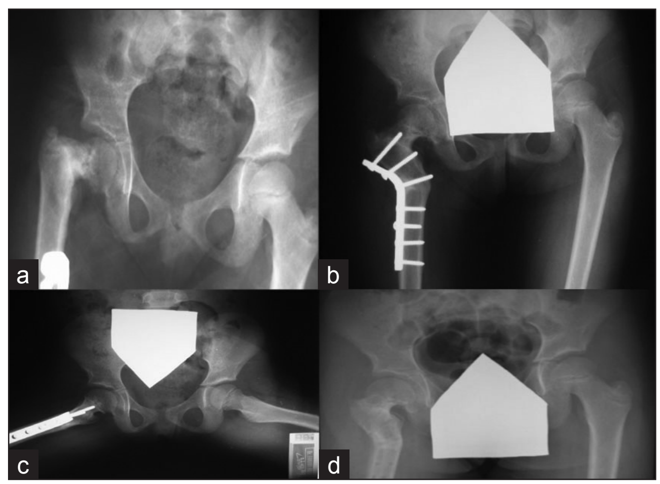

Figure 2: (a) X-ray pelvis with both hips (anteroposterior view) in a 9-year-old female showing DCV of the right hip and 4.5 cm shortening. Anteroposterior and frog leg lateral X-ray (b,c) at 18 months followup showing a valgus subtrochanteric osteotomy fixed with a 7-hole small DCP. Note the optimal correction of the growth plate orientation as compared to the sound hip. (d) Same patient after plate removal 1.5 years postoperative

Table 1: Pre and postoperative clinical and radiologic results

Patient no.	Preop. CS	Postop. CS	Preop. EHA	Postop. EHA	Change	Preop. HSA	Postop. HSA	Change
1	54	93	85	25	60	88	117	29
2	60	88	65	28	37	100	125	25
3	55	92	70	20	50	97	120	23
4	65	95	78	22	56	94	118	24
5	59	92	90	27	63	86	115	29
6	67	90	65	30	35	99	123	24
7	63	91	86	33	53	90	120	30
8	61	93	65	32	33	100	123	23
9	56	92	75	26	49	98	122	24
10	63	91	86	22	64	85	115	30
Mean	60	91	76.5	26.5	50	93.7	119.8	26.1

EHA = Epiphyseal-Hilgenreiner angle, HSA = Head shaft angle, CS = Clinical score to a recent study that used the same fixation method with equally good clinical and radiologic results.[4]

We did not encounter any no case of recurrence of the deformity. The average postoperative EHA recorded in this study was 26° (range 20°–33°). This goes in line with the conclusion of many authors that correction of the EHA to a value ≤45° is a crucial factor for prevention of deformity recurrence.[3,4,9,14] This conclusion is also supported theoretically by the biomechanical work of Pauwel.[7] Nevertheless, relatively short followup is an important limitation of the present study.

One patient with unilateral coxa vara had limb shortening of about 4.5 cm that was not fully explained on the basis of reduction of HSA or any trochanteric overgrowth. Skeletal survey for this patient did not link her with any form of generalized skeletal dysplasia. This finding suggests that there may be an element of femoral shortening at a more distal subtrochanteric level in some cases of developmental coxa vara.

In this study, the length of the straight vertical limb of the Y-shaped osteotomy is fixed, that is, one-third the diameter of the femur at the level of the osteotomy. This contrasts with Pauwel's osteotomy where the length of the vertical limb of the Y-shaped osteotomy is decided on basis of the infro-medial triangular fragment of the neck that needs to be supported. This is because in the current study not all hips showed the typical radiologic finding of infero-medial triangular fragment.

We planned the osteotomy level immediately below the second hole of the contoured plate. This takes the osteotomy to a subtrochanteric level in contrast to Pauwel's osteotomy performed at a trochanteric level. The author believes that performing the valgisation osteotomy at a subtrochanteric level provides equally efficient deformity correction as at trochanteric level, but with a significantly rigid fixation that obviates the need of postoperative casting. A radiologic disadvantage of a subtrochanteric osteotomy is the creation of a secondary angular deformity in the form of femoral shaft kinking distal to the primary deformity that has been shown to remodel significantly in this series with no negative influence on function.

A clear advantage of a Y-shaped osteotomy over the classic V-shaped osteotomy where the two limbs of the osteotomy meet at the medial cortex is that in Y-shaped osteotomy with a closing and opening wedge component, the amount of bone resected at the base of the wedge on the lateral cortex is less and, consequently, postoperative shortening.

In conclusion, the Y-shaped subtrochanteric valgus osteotomy for correction of developmental coxa vara is easily reproducible, efficient in deformity correction with no evidence of deformity recurrence. The internal fixation by precontoured DCP allows early mobilization of the child without any postoperative splinting.

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